DOE/CBFO-97-1224

Safety Evaluation Report

of the

Waste Isolation Pilot Plant

Contact Handled (CH) Waste Documented Safety Analysis

U.S. Department of Energy
Carlsbad Field Office

Revision 2
September 2005

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APPROVAL

Safety Evaluation Report
of the
Waste Isolation Pilot Plant
Contact Handled (CH) Waste Documented Safety Analysis

U. S. Department of Energy
Carlsbad Field Office

Date: **September 2005**
Revision Number: **DOE/CBFO-97-1224, Rev. 2**

Approved: *(signature on file)*
Dae Chung, Director, Office of Licensing (EM-24)
U. S. DOE Office of Environmental Management

EXECUTIVE SUMMARY

Introduction

This Safety Evaluation Report (SER) documents the Department of Energy's (DOE's) review of Revision 9 of the *Waste Isolation Pilot Plant Contact Handled (CH) Waste Documented Safety Analysis*, DOE/WIPP-95-2065 (WIPP CH DSA), and provides the DOE Approval Authority with the basis for approving the document. It concludes that the safety basis documented in the WIPP CH DSA is comprehensive, correct, and commensurate with hazards associated with CH waste disposal operations. The WIPP CH DSA and associated technical safety requirements (TSRs) were developed in accordance with 10 CFR 830, *Nuclear Safety Management*, and DOE-STD-3009-94, *Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Safety Analysis Reports*.

The WIPP is managed by the DOE and is designed to permanently dispose of transuranic (TRU) waste left from United States nuclear weapons research and production programs. The WIPP is a mined repository located 2,150 feet underground in a stable, ancient salt formation in southeastern New Mexico, 26 miles east of Carlsbad. Site facilities include structures, buildings, and underground excavations.

The DOE was authorized by Public Law 96-164 to provide a facility for demonstrating the safe disposal of TRU wastes from national defense activities and programs of the United States exempted from regulation by the U.S. Nuclear Regulatory Commission. The WIPP was constructed to determine the efficacy of an underground repository for safe disposal of TRU wastes.

CH TRU waste disposal operations began March 26, 1999, after the successful demonstration of compliance with applicable federal and state laws and regulations and the completion of the WIPP CH TRU operational readiness review, which verified that the facility was operationally ready and that CH waste disposal operations would be conducted safely at WIPP. Subsequent waste disposal operations have affirmed this.

WIPP waste disposal operations are scheduled to last 35 years. They will consist of receiving, handling, and emplacing radioactive mixed waste in the repository for permanent disposal.

Review and Approval Strategy for the WIPP CH DSA

As a result of concerns expressed during a DOE Environmental Management (EM) site visit in September 2004, the following major changes were made in Revision 9 of the WIPP CH DSA:

- The structure and format of the document was revised to be consistent with that used in DOE-STD-3009.
- A new hazard analysis was performed, using a systematic approach, to ensure that all plausible hazards were considered.
- New accidents were identified for detailed analysis based on the application of the new hazard analysis.
- The set of controls needed for protection of workers and the public was revised in light of the changes in the hazard and accident analyses.
- The TSR document was revised to reflect the revised control set; to differentiate

between programmatic and specific administrative controls in accordance with DOE-STD-1186-2004, *Specific Administrative Controls*; and to clarify the bases of the various TSRs, as well as the conditions under which TSRs are violated.

The focus of the review was on these changes to ensure that they adequately addressed the EM review team concerns.

This SER and the attendant review were conducted in accordance with Carlsbad Field Office (CBFO) Management Procedure (MP) 4.2, Revision 3, *Document Review*, and with the guidance provided in DOE-STD 1104-96, *Review and Approval of Nonreactor Nuclear Facility Safety Analysis Reports*. The SER and review focused on ensuring the comprehensiveness and validity of the revised hazard and accident analyses in the DSA and the resulting TSRs. The review team worked closely with Washington TRU Solutions (WTS) during the extensive revisions to the document. A streamlined comment resolution process was employed to allow CBFO input to be provided as the document revision was taking place. This process allowed the extensive changes to be efficiently incorporated into this revision in a timely manner.

Results and Conclusions

The conclusion of this SER is that the safety basis analyzed and documented in Revision 9 of the WIPP CH DSA (DOE/WIPP-95-2065) is comprehensive, correct, and commensurate with hazards associated with waste disposal operations, and that such operations will pose minimal risk to workers, the public, or the environment if conducted within the safety basis documented in this DSA, as modified by the condition specified below and in section 7.0 of this SER. This SER documents the DOE's review of Revision 9 of the WIPP CH DSA and provides the DOE Approval Authority with a defensible basis for approving it.

One condition of approval resulted from the DOE's DSA approval review reported in this SER. This condition of approval, discussed in sections 4.5 and 7.0, states that SAIC 1171-001, Revision 1, *Nuclear Criticality Safety Evaluation for Storage of Machine Compacted Transuranic Waste at the Waste Isolation Pilot Plant*, February 2005 (the NCSE), shall be revised to reflect a more representative base case and contingency analyses, which may analyze the form, distribution, credible masses, geometry, neutron poisons, and fuel density, as well as any other consistent factors that would influence the nature of criticality as it relates to storage in the Waste Handling Building (WHB) and disposal underground at the WIPP. These analyses shall develop a “realistically conservative” drum/semi-infinite array storage model that shall include contingency analyses that more accurately reflect the bounding waste storage and disposal configurations. Preparation of this NCSE revision shall be incorporated in the next annual revision of the DSA. A preliminary analysis satisfying these requirements has been prepared as an addendum to the NCSE and submitted to the Approval Authority along with Revision 9 of the CH DSA. This addendum includes a revised base case condition and fissile mass over batch contingent conditions in the underground repository array, using more realistic modeling assumptions. A number of different configurations of fissile material, moderator/ reflector, and compaction densities were modeled using these more realistic assumptions, resulting in maximum reactivities less than 0.88.

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ACRONYMS

AA	accident analysis
AC	administrative control
ALARA	as low as reasonably achievable
ARF	airborne release fraction
BDBA	beyond design basis accident
BR	breathing rate
C&C	Consultation and Cooperation
CBFO	Carlsbad Field Office
CH	contact-handled
DBA	design basis accident
DF	dose conversion factor
DID	defense-in-depth
DOE	U. S. Department of Energy
DR	damage ratio
DR/AM	document review/approval matrix
DRR	documented review record
DSA	Documented Safety Analysis
EG	evaluation guideline
EM	Environmental Management
GXQ	code used to calculate X/Q
HA	hazard analysis
HAZOP	Hazard and Operability Study
LCO	limiting condition of operation
LCS	limiting control setting
LPF	leak path factor
MHE	mitigated hazard evaluation
MP	management procedure
MSHA	Mine Safety and Health Administration
NCSE	Nuclear Criticality Safety Evaluation
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
SAR	Safety Analysis Report
SARP	safety analysis report for packaging
SC	safety class
SER	safety evaluation report
SL	safety limit
SMP	safety management program
SR	surveillance requirement
SS	safety significant
SSCs	structures, systems, and components
STD	standard
TRU	transuranic
TRUDOCK	transuranic waste dock
TRUPACT-II	Transuranic Package Transporter Model II
TSR	technical safety requirement
UHE	unmitigated hazard evaluation
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
WTS	Washington TRU Solutions
X/Q	atmospheric dispersion factor

1.0 INTRODUCTION

1.1 Safety Evaluation Report Purpose

Pursuant to 10 CFR 830, *Nuclear Safety Management*, the U. S. Department of Energy (DOE) must conduct an independent, defensible review in order to approve a Documented Safety Analysis (DSA). Subpart B, Appendix A, Subsection F of 10 CFR 830 states in particular: "DOE will prepare a Safety Evaluation Report to document the results of its review of the documented safety analysis. A documented safety analysis must contain any conditions or changes required by DOE." That review and the DSA approval bases are documented in this Safety Evaluation Report (SER). This SER documents the DOE's review of the *Waste Isolation Pilot Plant Contact Handled (CH) Waste Documented Safety Analysis*, DOE/WIPP-95-2065, Rev. 9 (WIPP CH DSA) and provides the WIPP CH DSA Approval Authority with the basis for its approval. The SER concludes that the safety basis documented in the WIPP CH DSA, when modified by the condition of approval required by section 7.0 of this SER, is comprehensive, correct, and commensurate with the hazards associated with waste disposal operations, and that it complies with all the requirements of 10 CFR 830.

1.2 Facility Identification, Background, and Mission

Administered by the CBFO, the WIPP is designed to permanently dispose of transuranic (TRU) waste left from United States nuclear weapons research and production. Project facilities are located in southeastern New Mexico, 26 miles east of Carlsbad, NM. The facilities include surface structures, disposal rooms, and other excavations mined 2,150 feet beneath the earth's surface in a stable, ancient salt formation.

The DOE was authorized by Public Law 96-164 to provide a facility for demonstrating the safe disposal of TRU wastes from national defense activities and programs of the United States exempted from regulation by the U.S. Nuclear Regulatory Commission. The WIPP was constructed to determine the efficacy of an underground repository for safe disposal of TRU wastes.

Development of the WIPP began in the early 1970s with a siting phase. During the siting phase, several potential sites were evaluated. The present site was selected based on extensive geotechnical research supplemented by testing. At the conclusion of the site and design validation and the construction phases, the DOE proposed a test phase to be followed by the waste emplacement and disposal phase. The test phase was to involve the use of limited quantities of CH TRU waste to conduct tests in the WIPP repository to provide data for reducing the uncertainties in the performance assessment required for compliance with the long-term waste isolation regulations of the U.S. Environmental Protection Agency, found in Subpart B of 40 CFR Part 191.

As a result of major program redirection in late 1993, the WIPP test phase was modified by replacing the previously planned WIPP underground radioactive tests with laboratory tests. Thus, WIPP operations were scheduled to proceed directly with the disposal phase. CH TRU waste disposal operations began on March 26, 1999, after the successful demonstration of

compliance with applicable federal and state laws and regulations and the completion of the WIPP CH TRU operational readiness review.

The disposal phase is projected to last 35 years. It will consist of receiving, handling, and emplacing TRU waste in the repository for disposal.

1.3 Facility Hazard Classification

The hazard classification was determined in accordance with DOE Standard (STD)-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.* A deterministic approach was taken without considering facility segmentation, form, location, or dispersibility of the material at risk. The material at risk for the determination of the hazard category was defined as the maximum potential radiological content of a single CH waste container. The WIPP is classified as a Hazard Category 2 facility based on this single waste container inventory, in comparison to the threshold quantities provided in DOE-STD-1027-92.

1.4 WIPP Documented Safety Analysis History and Approach

The WIPP Safety Analysis Report (SAR) was originally issued in May 1990 following approval by the DOE Office of Environmental Restoration and Waste Management to support the aforementioned test phase and subsequent waste disposal operations at the facility. It satisfied (1) the commitments in the Working Agreement for Consultation and Cooperation (C&C Agreement) between the State of New Mexico and the DOE, and (2) the requirements of DOE Order 5481.1B, *Safety Analysis and Review System.* The DOE Office for Safety, Health and Quality Assurance (EH-30) prepared a SER to document the DOE's review of, and approval basis for, the original WIPP SAR (May 1990).

The WIPP SAR was modified significantly during the FY95 annual update (DOE/WIPP-95-2065, Rev. 0). Subsequent annual updates continued to incorporate administrative and facility changes into the SAR and ensure it was kept current. The DOE began disposing of waste at WIPP in March 1999, within the safety basis documented in Revision 3 of the SAR (DOE/WIPP-95-2065, Rev. 3). Significant modifications were incorporated in Revision 5 of the SAR to ensure its compliance with 10 CFR 830. In light of the significance of these changes, the DOE decided that a complete revision of the SER (DOE/CAO-97-1224, Rev. 0) was warranted. That revision (DOE/CBFO-97-1224, Rev. 1) satisfied the requirements for documented safety analysis review and approval in accordance with Subpart B, Appendix A, Subsection F of 10 CFR 830.

Revisions continued to be made during each annual review of the SAR to reflect changes in facility operation and to keep the SAR consistent with changes in regulations and associated standards and guidance. These changes included changing the name of the SAR to the WIPP Contact Handled (CH) Documented Safety Analysis in Revision 8 of the document in order to reflect the current 10 CFR 830 terminology. Each of these revisions was approved by an addendum to Revision 1 of the SER.

In September 2004, a team from the DOE-EM Office of Licensing performed an assessment of the WIPP safety basis documentation. Based on observations by the assessment team, a number of major changes were made to the FY 2005 revision of the WIPP CH DSA (DOE/WIPP-95-2065, Rev. 9). Due to the significance of these changes, it was decided that a new SER should be prepared in lieu of another addendum. This SER (DOE/CBFO-97-1224, Rev. 2) was thus prepared to document the approval of Revision 9 of the WIPP CH DSA.

The safety basis for handling and emplacement of CH TRU waste for disposal at the WIPP established and analyzed in Revision 9 of the DSA consists of management, design, construction, operation, and engineering characteristics necessary to protect the public, workers, and environment from the safety and health hazards posed by CH waste disposal operations. The WIPP CH DSA includes an analysis of hazards associated with normal operations, external events, and natural phenomena, as well as a detailed evaluation of the consequences resulting from design basis and beyond design basis accident scenarios.

The hazard analysis technique used in the DSA employs a hybrid approach incorporating elements of the What-If/Checklist and Preliminary Hazard Analysis methods that qualitatively rank hazards by likelihood and significance of consequence. Hazards were systematically identified and assessed to evaluate the potential operational, external, and natural phenomena events that can cause the identified hazards to develop into accidents. The hazard assessment employed at the WIPP identified deviations from the intended design and operation of the waste handling system, examined potential consequences to the public and workers, estimated likelihood of occurrence, and evaluated associated preventive and mitigative features. Subsequently, the consequences of accident scenarios identified in the hazard assessment were quantitatively analyzed.

In evaluating hypothetical accidents, conservative assumptions were made to provide bounding consequences. These include, but are not limited to, conservative values for frequency estimates, container inventory, material at risk, damage ratio, leak path factor, and air transport modeling assumptions. The use of conservative assumptions to bound the full range of possible accident scenarios provides reasonable assurance that (1) the safety envelope of the WIPP facility is defined, (2) the design of the facility is adequate in response to the accident scenarios analyzed, and (3) the technical safety requirements (TSRs) assigned will provide satisfactory protection of the public, workers, and environment.

For the purpose of safety analysis, the WIPP is a radioactive/hazardous materials handling/storage and disposal facility. There are no complex systems or processes involved in current or planned waste disposal operations, and no identified energy sources are available to disperse materials in the event of an accident. Consequently, material handling accidents involving CH TRU waste are the dominant accident scenarios or mechanisms analyzed in the WIPP CH DSA.

2.0 DSA REVIEW PROCESS

The WIPP CH DSA review was performed in accordance with CBFO Management Procedure (MP) 4.2, Revision 3, *Document Review*, by a team composed of DOE personnel from CBFO and contract personnel from the CBFO Technical Assistance Contractor (CTAC) who are

technically qualified in the subject matter. Review team members with the required qualifications were selected by senior CBFO management in accordance with CBFO MP 4.4, Revision 4, *Document Preparation and Control*. The CBFO Safety Officer performed the role of review team leader. The review team leader is responsible for performing a defensible, independent review of the WIPP CH DSA. The CBFO Authorization Basis Senior Technical Advisor served as senior advisor for the review. Other CBFO and CTAC staff members completed the review team. Specified members of CBFO and CTAC staffs were delegated by CBFO review team members to review certain portions of the DSA, based on their respective qualifications and areas of interest or responsibility.

All review team members have degrees in the physical sciences or engineering, and experience in safety analysis methodology and applications. Collectively, the review team members have training and experience in radiation protection, nuclear safety, nuclear criticality analysis, industrial safety and hygiene, mine safety, and conduct of operations.

The review establishing the DOE's approval basis for the WIPP CH DSA was performed by the DSA review team to provide the Approval Authority the justification for approving the document. It was conducted in accordance with the guidance provided in DOE-STD-1104-96, *Review and Approval of Nonreactor Nuclear Facility Safety Analysis Reports.* Details of the DOE's approval basis review of the WIPP CH DSA, including conclusions and conditions of approval, are documented in this report.

The review process reported in this SER consisted of iterative reviews and comment resolution meetings between the review team and the Washington TRU Solutions (WTS) Nuclear Safety Group, the authors of the document. Those reviews and meetings resulted in discussion of issues, development and resolution of formal comments, and resulting revisions to the draft DSA. The development of Revision 9 of the WIPP CH DSA was accomplished by WTS as the Management and Operating Contractor, but the review and comment resolution process was interactive, with extensive discussions among the DSA authors and the review team.

3.0 WIPP CH DSA FORMAT

Previous versions of the WIPP DSA employed a format that was different from the 17-chapter structure of DOE-STD-3009-94. The previous format was organized in accordance with recommendations of Nuclear Regulatory TD Guide 3.26, *Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants*, pursuant to commitments made with the State of New Mexico in the C&C Agreement. The previous format consolidated all the required material into 10 chapters, which were titled to represent their individual contents as follows:

Chapter 1 - Executive Summary
Chapter 2 - Site Characteristics
Chapter 3 - Principal Design and Safety Criteria
Chapter 4 - Facility Design and Operation
Chapter 5 - Hazard and Accident Analysis
Chapter 6 - Derivation of Technical Safety Requirements
Chapter 7 - Radiological and Hazardous Material Protection
Chapter 8 - Institutional Programs

Chapter 9 - Quality Assurance
Chapter 10 - Decontamination and Decommissioning

Previous DSA revisions prepared in this format contained a table that correlated topics required by DOE-STD-3009-94 with the particular DSA chapters that contained them.

Based on concerns expressed by the DOE-EM review team that performed a review of the WIPP safety basis documentation in September 2004, the format and structure of Revision 9 of the CH DSA has been revised to reflect the 17-chapter format provided in DOE-STD-3009.

4.0 APPROVAL BASES

DOE's review of the safety basis established in Revision 9 of the WIPP CH DSA for CH TRU waste disposal operations consists of the review team's assessment of five key bases of DSA information, which are listed below:

Basis	DSA Chapters and Other Documentation
1. Base Information	Executive Summary, Chapter 1 (Site Characteristics), Chapter 2 (Facility Description).
2. Hazard and Accident Analysis	Chapter 3 (Hazard and Accident Analysis)
3. Safety Structures, Systems, and Components	Chapter 4 (Safety Structures, Systems, and Components)
4. Derivation of Technical Safety Requirements	Chapter 5 (Derivation of the Technical Safety Requirements) and the TSR document
5. Safety Management Program Characteristics	Chapters 6-17 covering management and programmatic considerations related to the assurance of safe operations.

Revision 9 of the WIPP CH DSA was reviewed for adequacy in relation to each basis listed above. The focus of the review was on bases 2 (Hazard and Accident Analysis), 3 (Safety Structures, Systems, and Components), and 4 (Derivation of Technical Safety Requirements), since those were the areas in which the major changes have occurred since the last DSA revision. The other bases were reviewed to the extent that they were affected by the current changes and to ensure consistency throughout the document. This SER summarizes the results and conclusions of the DOE's review.

4.1 Base Information

DOE-STD-1104-96 recommends that DSA base information be evaluated with regard to sufficiency to allow assessment of the other approval bases that rely on base information. Also, the guidance recommends that a SER's statement of adequacy of base information be focused and brief. The DOE's review of base information DSA chapters found that the WIPP CH DSA contains sufficient background and fundamental information to support the review of the remaining four approval bases, the more technical aspects of the review.

The base information included in the WIPP CH DSA is complete and documented in accordance with the requirements of 10 CFR 830, Subpart B, and DOE-STD-3009-94. The WIPP CH DSA segregates base information into two categories: (1) a detailed description of the physical site where the surface structures and underground excavations are or will be situated, and (2) a detailed description of facility design and operations. The base information provided in the WIPP CH DSA is sufficient to select the Hazard Category Classification of the facility, analyze hazards and postulated accidents, and derive appropriate TSRs to ensure safe operations. The safety basis established in the WIPP DSA is supported by accurate, complete base information.

Because of the nature of the WIPP facility, site characteristics have been thoroughly studied. The WIPP is a first-of-a-kind facility designed to permanently dispose of transuranic waste from United States nuclear weapons research and production programs. Conventional site characteristics, as well as geological and hydrological aspects of the WIPP site related to disposal of waste in the Salado Formation, have been carefully studied. The studies have included thorough, independent oversight and public scrutiny covering more than 20 years. The WIPP CH DSA includes a detailed summary of many of those studies, resulting in a thorough description of site characteristics provided in Chapter 1.

Chapter 2 of the WIPP CH DSA discusses the design of the facility and the design and operation of waste handling equipment. It also describes the CH waste handling process. This information provides the foundation upon which to base the hazard and accident analyses discussed in Chapter 3.

The WIPP facility includes surface support buildings, a waste handling building, four mine shafts, and the mined underground operations and waste disposal areas. The waste disposal operations are not complex. They primarily involve receiving, handling, and transporting to underground disposal rooms sealed containers holding radioactive mixed waste. Waste is handled and emplaced as received from generator sites. No waste characterization or processing is performed at WIPP. Any required waste characterization or processing activities are conducted at waste generator sites before the waste is transported to WIPP.

4.2 Hazard and Accident Analyses

Hazards associated with normal WIPP operations include mining dangers, rotating machinery, high voltage, compressed gases, confined spaces, radiological and nonradiological hazardous materials, ionizing and non-ionizing radiation, high noise levels, mechanical and moving equipment dangers, working at heights, construction, and material handling dangers. Waste handling operations at the WIPP do not involve high temperature and pressure systems, or electromagnetic fields. Routine occupational hazards are regulated by DOE-prescribed Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) standards.

Hazard analysis for the WIPP CH DSA consisted of hazard identification followed by hazard evaluation. During hazard identification, information was gathered about the various process hazards that might lead to accident scenarios. The information gathering process included physical walk-downs, information walk-downs, and discussions with subject matter experts. The physical walk-down, guided by WIPP facility experts, consisted of a comprehensive tour of the

CH waste handling areas, and included detailed discussions of the layout and activities conducted in those areas. Information walk-downs included a review of the available facility description and inventory information, supporting operational safety studies, and consultations with system engineers and process experts. The information gathering process resulted in a comprehensive list of potential facility hazards, which was then screened to eliminate standard industrial hazards, which are not considered in DSA hazard and accident analyses except where they may be initiators for a release of radioactive or hazardous material.

The hazard evaluation process consisted of an unmitigated hazard evaluation (UHE), in which hazard-initiated events were qualitatively evaluated for frequency and consequences without the benefit of preventive or mitigative controls, and a mitigated hazard evaluation (MHE), performed to demonstrate that adequate preventive and mitigative features were selected to reduce the unmitigated event risk to the on-site and facility worker groups. The results of the UHE were used to identify the events that require further evaluation in the MHE for events posing significant risk to workers and in accident analysis for events posing a significant risk to the public. Accident analysis results were compared to the Evaluation Guideline (EG) to determine the need for safety class structures, systems, and components (SSCs) or administrative controls to protect the public. The MHE resulted in selection of controls for the protection of on-site and facility workers.

Defense-in-depth (DID) considerations were integrated into this process using the following philosophy:

DID as an approach to facility safety has extensive precedent in nuclear safety philosophy. It builds in layers of defense against release of hazardous materials so that no one layer by itself, no matter how good, is completely relied upon. This includes protection of the barriers to avert damage to the plant and to the barriers themselves. It includes further measures to protect the public, workers, and the environment from harm in case these barriers are not fully effective. The first layer of DID involves barriers to contain uncontrolled hazardous material or energy release. The second layer of DID involves preventive systems to protect those barriers and the third involves systems to mitigate uncontrolled hazardous material or energy releases upon barrier failure.

In the CH DSA, DID is described as it pertains to 5 areas of the WIPP process:

- Waste handling above ground prior to moving TRUPACT-IIs and HalfPACTs into the WHB
- Waste handling inside the WHB
- Waste hoist operations
- Waste handling underground prior to panel or room closure
- After panel closure

DOE finds that the hazard analysis approach described above is consistent with the guidance provided in DOE-STD-3009-94 and represents a proper application of the graded approach to a facility of the type and complexity of WIPP.

Events determined through the UHE to require accident analysis were grouped into the following categories: fires, explosions, loss of containment or confinement, nuclear criticality, external

hazards (e.g., airplane crashes, pipeline explosions) and natural phenomena (e.g., earthquakes, tornadoes). Those accidents determined as a result of quantitative accident analysis to result in unmitigated consequences exceeding or challenging the 25 rem EG included earthquakes, underground fires, flammable gas explosions in the WHB and underground, waste hoist fire and/or failure, equipment or material dropped down the waste shaft onto a conveyance car load of waste, an underground roof collapse, and hail and snow accumulation on the WHB roof.

DOE notes as a result of its review that the multiple forklift fire in the WHB considered as a beyond design basis accident (BDBA) resulted in unmitigated consequences conservatively estimated to be higher than those from the single forklift DBA event, which could result in the identification of necessary additional controls or raise the classification of existing controls identified in the single forklift fire. However, in light of the fact that the multiple forklift fire is beyond design basis and that controls are already in place to prevent the design basis single forklift fire, DOE agrees that evaluation of additional controls or upgrading existing controls to prevent the multiple forklift fire event would not be cost effective given the extremely low frequency that would be expected for such an event.

In September 2004, a team from the DOE-EM Office of Licensing performed an assessment of the WIPP safety basis documentation. Based on observations by the assessment team, a number of major changes were made to the hazard and accident analyses in the WIPP CH DSA and to the associated TSR document. The structure and format of the document was revised to adhere to that used in DOE-STD-3009. As explained in Section 3.0, previous revisions of the WIPP CH DSA contained all the content required by DOE-STD-3009, but presented it in a 10-chapter format that had been agreed upon between CBFO and the State of New Mexico. Although a crosswalk was provided to show equivalency, the use of the non-standard format caused confusion during reviews and made it more difficult to trace the selection of accidents for quantitative analysis and the development of controls. Changing the document to the 17-chapter format of DOE-STD-3009 has alleviated these problems and simplified the presentation of hazard and accident analysis results and their relationship to control selection and TSR development.

A new hazard analysis was performed, using a systematic approach, to ensure that all plausible hazards were considered. The original Hazard and Operability Study (HAZOP), on which previous revisions of the CH DSA had been based, was outdated and did not effectively screen events to be carried forward for quantitative accident analysis. It was also found to not be comprehensive enough in identifying hazards, in light of the changes to the facility since it was performed. The new hazard analysis used a methodology more suitable for a facility of the type and complexity of WIPP. It employed a hybrid methodology consisting of a combination of the "What If/Checklist" and Preliminary Hazard Analysis methods. This allowed for a more comprehensive consideration of potential hazards and events and led to a more supportable determination of design basis accidents.

New types of accidents were added for detailed analysis based on the application of the new hazard analysis. These included explosions in waste containers, explosions external to waste containers, vehicle crash into the WHB, lightning strike to the WHB, fires outside the WHB propagating to the WHB, and snow/ice loading causing the WHB roof to collapse. In addition to

leading to the analysis of additional specific accidents, the use of the new hazard analysis resulted in a change in the types of accidents resulting in the highest consequences. For example, fires and earthquakes became more important in relation to other accident types than had been the case in previous revisions of the CH DSA.

The set of controls needed for protection of workers and the public was revised in light of the changes in the hazard and accident analyses. New controls were identified and some previous controls were elevated from defense-in-depth or balance of plant level controls to safety class or safety significant controls. This updated suite of controls will enhance the safety of workers and the general public.

The TSR document was revised to reflect the revised control set; to differentiate between programmatic and specific administrative controls in accordance with DOE-STD-1186-2004, *Specific Administrative Controls*; and to clarify the bases of the various TSRs as well as the conditions under which they are deemed to have been violated. These revisions have resulted in a set of TSRs that better reflect the operating realities of the facility.

DOE's review of chapter 3 of the WIPP CH DSA concludes that the hazard and accident analyses are consistent with the approach outlined in DOE-STD-3009-94, are appropriate for a facility of the type and complexity of WIPP and, with the incorporation of the changes listed above, provide a well-defined and supportable safety basis that will result in the continued safe operation of the facility. Specifically, DOE finds that the analyses of chapter 3:

- Systematically and comprehensively identify the potential hazards resulting from normal WIPP waste disposal operations,
- Effectively evaluate those hazards with regard to operational, external, and natural phenomena events that could develop into accidents,
- Assess associated preventative and mitigative features for defense-in-depth and worker safety and the selection of safety significant controls,
- Evaluate postulated accident consequences against the EG to identify needed safety class controls, and
- Effectively translate identified controls into TSRs.

DOE notes that the calculation of accident dose as a product of material at risk (MAR), damage ratio (DR), airborne release fraction (ARF), respirable fraction (RF), leak path factor (LPF), atmospheric dispersion factor (X/Q), breathing rate (BR) and dose conversion factor (DF) is consistent with the methodology suggested in DOE-STD-3009-94, Appendix A. DOE also finds that the selection of values for ARF and RF are consistent with those found in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, and that DR values selected are supported by referenced documentation. Values for LPF are conservatively selected to be 1.0 for most cases and, where different from 1.0, are justified by referenced studies or application of engineering judgment. The selection of MAR for each accident scenario is scenario-dependent and is well supported by a calculation package referenced in the DSA. DOE notes that the air transport/dispersion code used to calculate X/Q values (GXQ) is not one of those included in the DOE Toolbox. However, DOE-STD-3009-94

requires only that the code used be consistent with Nuclear Regulatory Commission (NRC) Regulatory Guide 1.145 and that it be appropriately documented in accordance with software quality assurance requirements. Since the GXQ code meets both of these requirements, DOE concurs with its use.

Chapter 3 provides the primary bases to support the conclusion that CH TRU waste disposal operations can be conducted safely at the WIPP. To ensure the safe operation of the facility, waste disposal operations must be conducted within the safety envelope defined by the analyses provided in this chapter and implemented through the resulting TSRs.

4.3 Safety Structures, Systems, and Components

Safety SSCs include safety class (SC) SSCs and safety significant (SS) SSCs. Safety-class SSCs are defined in DOE-STD-3009-94 as "structures, systems, or components including portions of process systems, whose preventive and mitigative function is necessary to limit radioactive hazardous material exposure to the public, as determined from the safety analyses." Otherwise stated, SC SSCs are those SSCs whose preventive and/or mitigative function is necessary to keep radiological exposure to the public from exceeding or challenging the off-site evaluation guideline. The guideline specifies that a value of 25 rem (roentgen equivalent man) total effective dose equivalent to a maximally exposed member of the public be used as the threshold for identifying SC SSCs. In accordance with the accident analysis results in Chapter 3 of the DSA, the WHB, the waste handling equipment automatic fire suppression systems, and the waste hoist structure and structural support, including the waste hoist head frame, waste shaft conveyance, counterweight, ropes, waste hoist drum, and structural support provided by the waste hoist tower, are designated SC. The safety function of the WHB is to prevent roof collapse during a seismic event or due to snow and ice loading. The safety function of the waste handling equipment automatic fire suppression systems is to extinguish vehicle fires associated with fuel line leaks and the vehicle engine, thus preventing small fires from becoming large fires in the underground. The safety function of the waste hoist structure and structural support is to ensure that the waste shaft conveyance will not fall into the waste shaft in an uncontrolled manner during normal operations and seismic events.

Safety-significant SSCs are defined as those SSCs not designated as safety class, but whose preventive or mitigative function is a major contributor to defense-in-depth and/or worker safety as determined from safety analyses. As discussed in DOE-STD-3009-94, safety-significant SSCs based on worker safety are limited to those SSCs whose failure is estimated to quickly result in worker fatality or serious injury or significant radiological or chemical exposure to workers.

The DSA has identified the following safety significant SSCs, along with their noted safety functions, as a result of the analyses in Chapter 3.

Fire water and fire suppression systems - to prevent small fires from becoming large fires, reduce the likelihood that a fire in the Support Building or TRUPACT Maintenance Facility will propagate to the Waste Handling Building, and protect the SC waste hoist structure from the effects of a large fire.

Waste hoist brakes - to prevent the uncontrolled movement of the waste shaft conveyance upon loss of power or loss of hydraulic pressure

Bulkheads, overcasts, and airlocks - to provide separation in the underground between construction ventilation circuit and disposal circuit and waste shaft station

Transuranic waste dock (TRUDOCK) cranes - to hold their load during the DBE or loss of power

Waste shaft collar fence - to define the restricted area surrounding the waste shaft and prevent uncontrolled access to the shaft

Conveyance loading car - to prevent a pallet of waste from inadvertently entering the waste shaft

Facility pallet - to prevent impact to waste containers from bulkhead doors

Waste hoist head frame - to prevent loading a facility pallet into the waste shaft from a forklift

Waste shaft conveyance - to allow only one facility pallet to be transported at a time

Underground ventilation - must be operating to ensure that in the event of a waste container breach, airflow is directed away from workers and towards the disposal array. Underground ventilation also ensures there is sufficient airflow to facilitate evacuation of underground workers in the event of underground fires.

DOE's review of the information in Chapter 4 of the DSA, as summarized above, reveals that the designation of these SSCs as safety class and safety significant follows directly and logically from the information developed in the hazard and accident analyses in Chapter 3. In accordance with DOE-STD-3009-94, Chapter 4 of the DSA also describes the safety function, functional requirements, and system evaluation for each of the safety SSCs. DOE has reviewed these descriptions and agrees that they adequately describe the operational requirements for each of these safety SSCs and how these requirements have been incorporated in the design of the respective SSCs to allow them to perform their required safety functions.

4.4 Derivation of Technical Safety Requirements

The purpose of Chapter 5 of the DSA is to derive the technical safety requirements that build upon the control functions determined to be essential in Chapter 3, Hazard and Accident Analysis, and Chapter 4, Safety Structures, Systems, and Components. This chapter consists of summaries and references to pertinent sections of the CH DSA in which design features (DFs) and administrative controls (ACs) are needed to prevent and/or mitigate the consequences of a postulated event. The limiting conditions for operation (LCOs), surveillance requirements (SRs), and necessary ACs determined in this chapter form the basis for the facility TSRs and provide the logical link between the TSRs and the DSA.

Review of Chapter 5 indicates that the information provided in the chapter provides assurance that TSR coverage for the WIPP is complete. The TSR controls logically flow from and ensure that the safety functions outlined in Chapters 3 and 4 of the DSA are operational, when required, and preserve the Initial Conditions. Chapter 3 identifies the controls necessary to prevent and/or mitigate potential hazardous events evaluated in this DSA. Chapter 4 identifies which SSCs are SC and SS. The safety SSCs and ACs identified in Chapter 3 are required to prevent and/or mitigate postulated events within WIPP and, therefore, they are evaluated for TSR coverage.

The Hazard Analysis (HA) and Accident Analysis (AA) take credit for the identified controls in one of two ways: (1) the controls are assumed to function as intended to reduce the frequency and/or consequences of a higher risk event, in which case they are passed to the TSRs as SSCs (active SSC or passive DF) or TSR AC; or (2) they are considered secondary defense-in-depth controls. This review has verified that all SSCs and ACs credited with prevention and/or mitigation in the AA and those required for worker protection have been incorporated into the TSRs via the derivations provided in Chapter 5.

All TSRs derived in Chapter 5 are in the form of Limiting Conditions of Operation (LCOs) or ACs (specific or programmatic). The discussions in Chapter 5 justify the fact that no Safety Limits (SLs) or Limiting Control Settings (LCSs) are needed due to the nature of WIPP operations and none have been specified. DOE concurs with this analysis and agrees that all controls are appropriately specified as LCOs or ACs.

4.5 Safety Management Program Characteristics

Safety management programs (SMPs) provide the basis for the TSR programmatic controls that help to ensure defense-in-depth and worker safety. These SMPs are described in Chapters 6-17 of the CH DSA and are summarized as follows:

Criticality Safety Program (DSA Chapter 6) - to ensure worker safety by prevention of inadvertent criticality associated with waste handling, storage, and emplacement operations

Radiation Protection Program (DSA Chapter 7) - to provide protection to workers and the off-site public from radiological hazards associated with the storage and emplacement of CH TRU and CH TRU mixed waste, including maintaining worker exposures As Low As Reasonably Achievable (ALARA)

Hazardous Material Protection Program (DSA Chapter 8) - to protect workers and the off-site public from nonradiological hazardous material exposures resulting from CH waste operations, including the occupational health program for monitoring and medical services for workers

Radioactive and Hazardous Waste Management Program (DSA Chapter 9) - to manage site-derived and site-generated radioactive and hazardous wastes in a manner consistent with the protection of the workers, the public, and the environment

Initial Testing, In-Service Surveillance, and Maintenance Programs (DSA Chapter 10) - to ensure that all SSCs, and especially safety SSCs, meet their functional and performance

requirements described in the DSA as necessary for protection of worker and off-site public safety

Operational Safety Program (DSA Chapter 11) - to provide for the orderly and proceduralized day-to-day operation (including conduct of operations and fire protection) of the WIPP facility in a manner designed to protect workers from radiological and hazardous chemical exposures, and from standard industrial hazards

Procedures and Training Programs (DSA Chapter 12) - to protect the assumptions in the DSA hazard and accident analyses that the WIPP facility is operated and maintained by personnel who are qualified and competent to carry out their job responsibilities using current and well-developed procedures

Human Factors Process (DSA Chapter 13) - to examine the importance of human factors in facility safety and to analyze the human-machine interfaces with SSCs important to safety or that provide DID

Quality Assurance Program (DSA Chapter 14) - to assure that work at WIPP is planned, documented, performed under controlled conditions, and periodically assessed in order to help ensure overall worker and public safety associated with WIPP operations

Emergency Protection Program (DSA Chapter 15) - to provide an organized plan of action for handling emergencies at WIPP and for mitigating their effects on workers and the off-site public

Decontamination and Decommissioning Plans (DSA Chapter 16) - to minimize the long-term effects of WIPP on the environment by providing a means of decontamination and decommissioning of surface and subsurface structures, restoring the site surface area to preconstruction and preoperational conditions, and to warn future generations of the presence of the WIPP repository

Management, Organization, and Institutional Safety Programs (DSA Chapter 17) - to ensure that WIPP is operated by the Management and Operating Contractor under a management and organizational structure that promotes an effective safety culture supported by institutional safety programs

DOE takes note in its review of these chapters that, with one exception, all of these SMPs have been in place since the beginning of WIPP operations and have exhibited demonstrated effectiveness. The exception is the criticality safety program. The NCSE for WIPP (SAIC 1171-001, Rev. 1) was originally adapted from the transportation safety analysis report for packaging (SARP) NCSE used for TRU waste transportation criticality safety modeling and NRC licensing for national transportation of TRU waste to the WIPP site. While this model is conservative and is intended to consider all possible transportation accident scenarios that could lead to a criticality event, it is not representative of the normal and accident conditions which would be present at the WIPP, either surface or underground. To this extent, the storage and disposal of TRU waste represents a unique and different set of hazards and conditions that would influence the occurrence of a criticality. Therefore, the current NCSE needs to be revised to reflect a more representative base case and contingency analyses, which may analyze the form,

distribution, credible masses, geometry, neutron poisons, and fuel density, as well as any other consistent factors that would influence the nature of criticality as it relates to storage in the WHB and disposal underground at the WIPP. These analyses need to develop a "realistically conservative" drum/semi-infinite array storage model that would include contingency analyses that more accurately reflect the bounding waste storage and disposal configurations. An addendum to SAIC 1171-001, *Nuclear Criticality Safety Evaluation for Storage of Machine Compacted Transuranic Waste Products at the Waste Isolation Pilot Plant*, dated May 23, 2005, has been prepared that provides preliminary analyses scoping these needs. This addendum includes a revised base case condition and fissile mass over batch contingent conditions in the underground repository array, using more realistic modeling assumptions. It showed that with a more uniform fissile material distribution in the base cases, contingencies can include various over-batch scenarios without encroaching on the upper subcritical limit. A number of different configurations of fissile material, moderator/reflector, and compaction densities were modeled using these more realistic assumptions, resulting in maximum reactivities less than 0.88. This addendum is submitted to the Approval Authority along with Revision 9 of the CH DSA. Revision of the NCSE itself is made a condition of approval of this DSA and it shall be incorporated in the next annual revision of the DSA. It should be noted that DOE does not consider the safety basis to be compromised by the current NCSE, but rather that the extreme conservatism in the assumptions provides insufficient flexibility for operational changes.

All of these SMPs undergo frequent internal and external reviews and are constantly undergoing process improvement to make them even better and more effective. DOE finds these SMPs to be adequate to perform their safety-related functions and for providing a basis from which the TSR programmatic ACs may be constructed.

5.0 TECHNICAL SAFETY REQUIREMENTS

The TSR document contains the WIPP CH TRU Waste TSRs that define the performance requirements of SSCs, administrative controls, and design features to ensure the safe operation of WIPP. All commitments for safety controls made in the DSA as a result of the hazard and accident analyses provided in Chapter 3 have been captured in appropriate TSR provisions.

Due to the nature of WIPP operations and the design of the facility, most of the TSRs for the WIPP facility are expressed in the form of specific or programmatic ACs. The WHB fire suppression system, fire water supply system, waste handling equipment automatic fire suppression systems, and underground ventilation system operation are the only controls protected by LCOs. Justification for treating all other controls as ACs has been provided in the hazard and accident analyses in Chapter 3 of the DSA in the discussions of the specific hazards or accidents to which they apply. DOE agrees that this strategy has been appropriately justified in the DSA.

DOE concludes as a result of its review of the specific TSRs that all TSRs are adequately defined and supported by justifiable basis statements and surveillance requirements in accordance with the guidance in DOE G 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*. In addition, DOE finds that specific administrative controls have been appropriately differentiated from programmatic ACs and have been established in a manner consistent with DOE-STD-1186, *Specific Administrative Controls*.

In its review of the specific TSRs, DOE notes that a completion time of 48 hours is invoked upon failure of the automatic fire suppression system on a piece of waste handling equipment. DOE recognizes that 48 hours is necessary to allow placing the waste in the safest condition as well as allowing for repair or replacement of the equipment. DOE agrees that the increase in risk of a fire that could result in radioactive and/or hazardous material release during this time period is extremely small given the use of a fire watch and other preventive and mitigative factors, including the fact that controls to prevent collision are still in place, manual actuation of the fire suppression system is still available, and the fact that waste handling equipment is powered by diesel fuel instead of gasoline. DOE accepts this extremely small increase in risk. DOE notes, however, that in the event that both automatic and manual portions of the fire suppression system are compromised, the completion time is reduced to 4 hours and agrees that this is a reasonable completion time under these circumstances.

6.0 RECORDS

Review of Revision 9 of the WIPP CH DSA was conducted in accordance with the general requirements in DOE-STD-1104-96. This review generated a Document Action Request (DAR) providing the formal request for review of the document, a Document Review/Approval Matrix (DR/AM) delineating the individual CBFO reviewers and the type of review to be conducted by each, and formal Document Review Records (DRRs) containing comments on the DSA and TSR document by the review team and the corresponding responses to those comments by the DSA and TSR document authors. The DAR, DR/AM, and DRRs are a part of the Administrative Record associated with this review and are available for inspection at CBFO.

7.0 CONDITION OF APPROVAL

The DOE's approval of Revision 9 of the WIPP CH DSA and associated TSR document is subject to the following condition, as discussed in section 4.5.

Nuclear Criticality Safety Evaluation

The NCSE (SAIC 1171-001, Rev. 1) shall be revised to reflect a more representative base case and contingency analyses, which may analyze the form, distribution, credible masses, geometry, neutron poisons, and fuel density, as well as any other consistent factors that would influence the nature of criticality as it relates to storage in the WHB and disposal underground at the WIPP. These analyses shall develop a "realistically conservative" drum/semi-infinite array storage model that shall include contingency analyses that more accurately reflect the bounding waste storage and disposal configurations. An addendum to the NCSE has been prepared and reviewed by DOE that provides preliminary analyses scoping these needs, as discussed in Section 4.5. This addendum shall be incorporated into the WIPP safety basis until such time as the NCSE is formally revised, which shall be no later than the next annual revision of the WIPP CH DSA.

8.0 CONCLUSIONS

Based on the results of the review team's assessment of Revision 9 of the WIPP CH DSA, DOE concludes that WIPP CH TRU waste operations are safe and will pose minimal risk to workers, the public, and the environment if conducted within the safety basis documented in the DSA, as

modified by the condition specified in section 7.0 of this SER. The DOE thus approves Revision 9 of the WIPP CH DSA as modified by the specified condition.

9.0 EFFECTIVE DATE

To allow for a reasonable implementation period, and in accordance with the memorandum from the Assistant Secretary for Environmental Management dated May 28, 2002, entitled Supplemental Environmental Management (EM) Guidance for Implementing 10 CFR 830, Subpart B, Safety Basis Requirements, the effective date of Revision 9 of the WIPP CH DSA and TSR shall be 90 days from the issuance of this SER.